ASSESSMENT OF AEOLIAN DUST PROPERTIES IN THE PORT HEDLAND AREA AND IMPLICATIONS FOR FUTURE AIR QUALITY MANAGEMENT STRATEGIES.

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Abstract

Substantial amounts of dust are generated in Port Hedland, an iron ore handling port 1300 km north of Perth in Western Australia, with particulates in the air exceeding acceptable levels on 55 days during 2010. In addition, the incidence of respiratory hospitalisation is 30% higher in the Port Hedland region than in the rest of Western Australia. The iron ore handling operations are currently suspected to be the major cause. However the contribution from other sources is poorly documented and as the industry grows in the area so too does the number of possible sources.

This pilot study reports the chemical composition of dust samples from 8 collection sites located up to 20 km from industrial facilities and compares the composition to that from 6 potential source locations. The samples were collected between the months of July and September 2010. Ion Beam Analysis was used to determine the chemical composition of the aeolian samples and Inductively Coupled Plasma – Atomic Emission Spectroscopy was used to determine the composition of the source samples. Elevated levels of Fe have been observed at all aeolian sample sites indicating widespread dispersion of iron ore dust; however when considered relative to Al, there appears to be a discrepancy between the composition of aeolian samples and iron ore products. This suggests a significant contribution from sources such as dredge spoil areas and areas disturbed by other infrastructure projects.

Further study to determine the elemental make up of dust from the Port Hedland area is being undertaken to determine the contribution made by the various emission sources in the area in the event that acceptable levels of airborne particulate matter are exceeded. This will provide an accurate means of designing air quality management and dust abatement strategies for the town and the industry groups as industrial expansion occurs.

Keywords: Aeolian, dust, Port Hedland , sources

Introduction

Port Hedland, an iron ore handling port 1300 km north of Perth in Western Australia, is currently, by export tonnage, one of the largest ports in the world with more than 170 million tonnes of iron ore shipped during 2010. Two years previously the tonnage shipped was only half that and as export expansion has occurred there has been similar doubling of the town, its infrastructure and service industries.

In addition to iron ore stockpiles and the construction of large spoil containment areas associated with the port, the construction of new civil infrastructure has disturbed mangrove flats and spinifex grasslands. During 2010, acceptable levels of particulates in the air (measured at Wedgefield, a residential area 3 km from iron ore handling facilities) were exceeded on 55 days. In addition, Mullen *et al.* (2006) have found that the annual incidence of respiratory hospitalisation in the Port Hedland region is 30% higher than in the rest of Western Australia. Thus the production and management of dust is an issue of concern for all stakeholder groups within the town, particularly as further expansion, which will see the export capacity of the port increased to 470 million tonnes/annum by 2015, is currently underway. Hence, there is a need for a collaborative broad scaled approach to manage air quality in the region.

This pilot study investigates the chemical characteristics of aeolian material found in the Port Hedland region to identify sources affecting the air quality. Their composition is compared to that of 6 potential source locatons from around Port Hedland. It provides objective data to assist in the design of management strategies by relevant industry or government bodies as a rapid expansion of the iron ore handling facilities continues.

Samples and methods

500 gram samples of iron ore dust (from the Fortescue Metals Group (FMG) and BHP Billiton stockpiles) and 4 other potential dust sources from around Port Hedland (Figure 1) were collected at ground level and analysed by Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES) analysis.

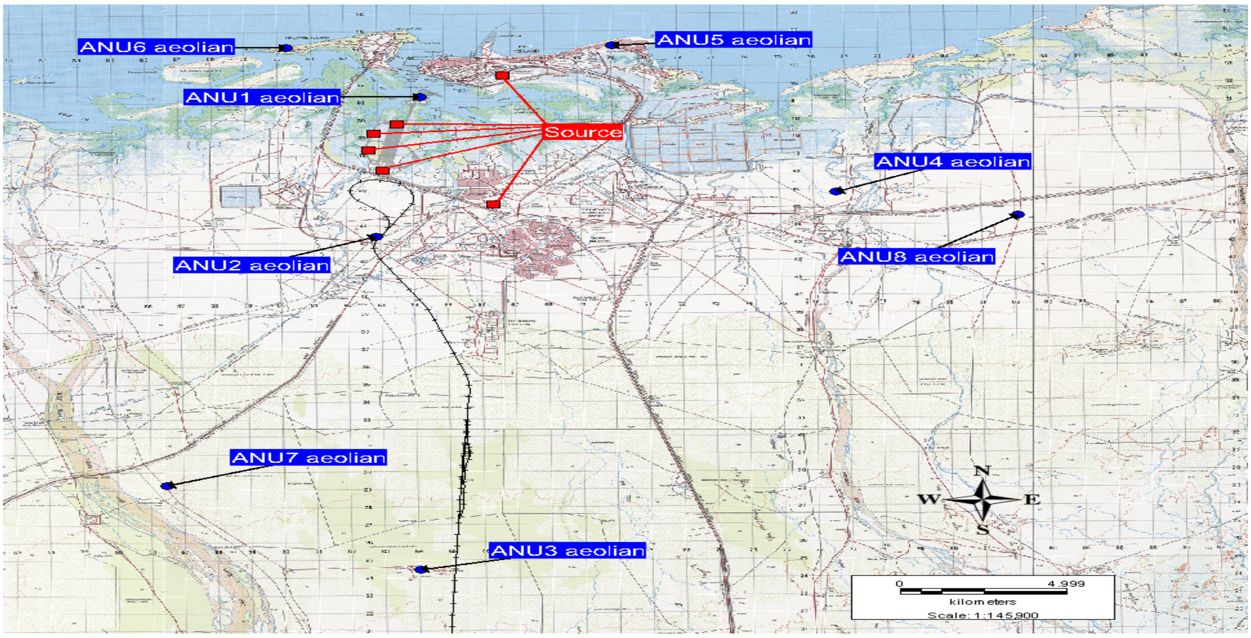

Figure 1: **Potential source and aeolian deposition sample site locations in the Port Hedland region**

Eight deposition gauges (established in accordance with *AS: 3580.14: Methods for sampling and analysis of ambient air*) around Port Hedland (at distances up to 20 km from the port: Figure 1) were monitored over the months of July, August and September 2010. Due to the low rainfall received during the collection periods, 150 ml of de-ionised water was used to wash the collection funnels and create a suspension capable of being filtered onto 25 mm nucleopore filters (Karlson *et al.* 2009). Ion Beam Analysis (IBA) data was obtained for 19 elements (Al, Si, P, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Br, Sr and Pb) present in aeolian material on the filter membranes.

Beta Attenuation Monitors (BAM) continually record ambient dust levels and meteorological conditions. At present the FMG BAM records wind directions from two sectors, the FMG sector (between 210^0 and 348^0 from the monitor) and the Wedgefield sector (360^0 around the monitor). When winds from either sector blow across the monitor, the PM^{10} in the air is recorded as emission from that sector.

Comparison of the chemical analysis results and the meteorological data was made to provide further analysis of potential source contribution.

Results

Table 1 displays the %Fe and %Al compositions and Fe: Al ratios of the FMG and BHP iron ore samples and 4 other potential source materials and selected aeolian samples collected during July, August and September 2010.

Table 1: **Percentages and Ratios of Fe and Al in source and selected aeolian samples**

Source samples	%Fe	%Al	Fe: Al
FMG stockpile	58.53	2.13	27.5:1
BHP Billiton stockpile	61.40	1.60	38.4:1
Dredge Spoil	0.877	0.303	2.9:1
Settlement area containment wall	0.822	0.188	4.4:1
Cleared land, Wedgefield	0.818	0.218	3.8:1
Exposed soil	0.487	0.100	4.9:1
Aeolian Samples			
ANU1 – July	69.51	2.53	27.5:1
- August	81.09	1.64	49.4:1
- September	60.07	3.60	16.7:1
ANU3 – July	44.76	3.21	13.9:1
– August	0.17	0.68	0.3:1
– September	15.52	10.22	1.5:1
ANU5 – July	4.89	0.74	6.6:1
– August	13.03	2.87	4.5:1
– September	43.92	7.14	6.2:1
ANU6 – July	46.47	3.50	13.3:1
– August	30.55	1.11	27.5:1
– September	22.77	1.58	14.4:1

Figure 2 displays the annual PM^{10} readings from the Wedgefield monitor relative to the dust derived from the FMG sector.

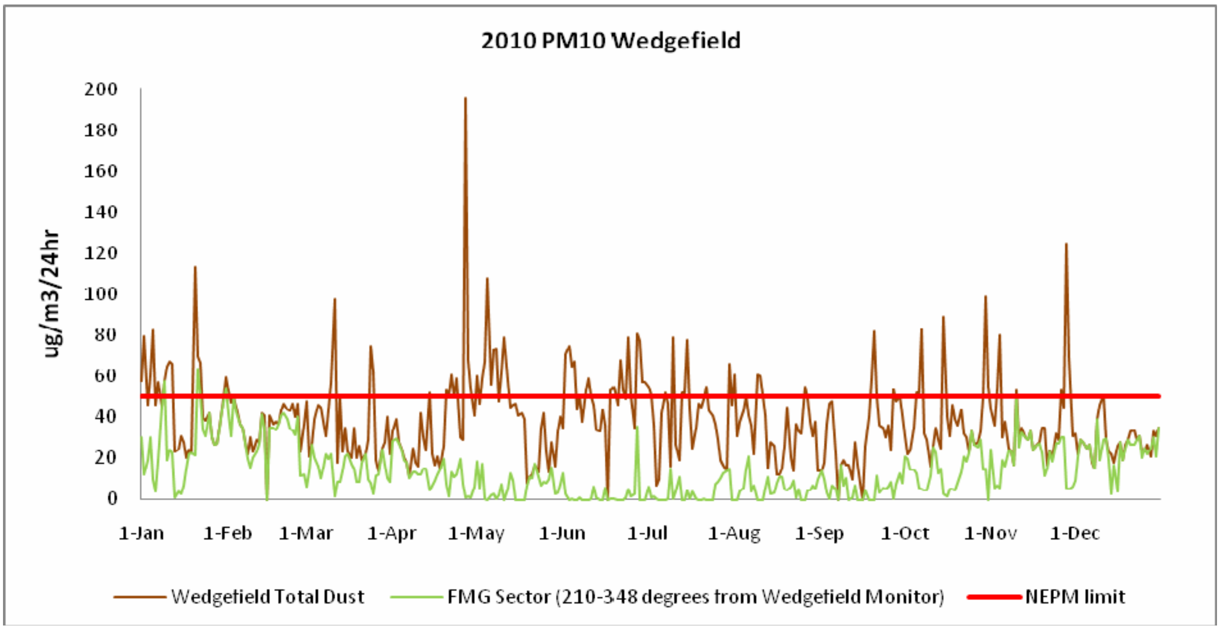

Figure 2: Continuous particle monitor PM^{10} readings 2010

Discussion

Table 1 and Figure 3 demonstrate that the iron ore stockpiles have low Al contents relative to their Fe contents (Fe/Al ratios >25:1) and are clearly differentiated from the 4 other potential dust source sites (Fe/Al~4:1). The aeolian samples from around Port Hedland generally plot about the Fe/Al =4:1 line and imply a major contribution of non-iron ore material. Exceptions are the aeolian depositions at ANU1, ANU6 and ANU3July. The former two sites are located immediately adjacent to the inner harbour (where large amounts of iron ore are handled) or to its west (Figure 1) and so they could be expected to receive iron ore dust throughout the sampling period. Indeed, previous studies in the Port Hedland region have demonstrated that iron ore stockpiles have been the source of airborne contamination of mangroves in the harbour area including to the west (Ong *et al.* 2003). Furthermore, the relatively low Fe/Al ratios for ANU5 to the east of the BHP-Billiton loading point are consistent with predominantly easterly winds during July-September. The occurrence of the Fe/Al ratio= 13.9 in ANU3 July but very low values for the other months at this site (immediately west of the rail line, 24 km from the port: Figure 1) may suggest contamination by an isolated event there during July. Thus sampling for a full 12 month period and the determination of features like the particle size distribution should be considered to properly assess the significance of the July data at ANU3.

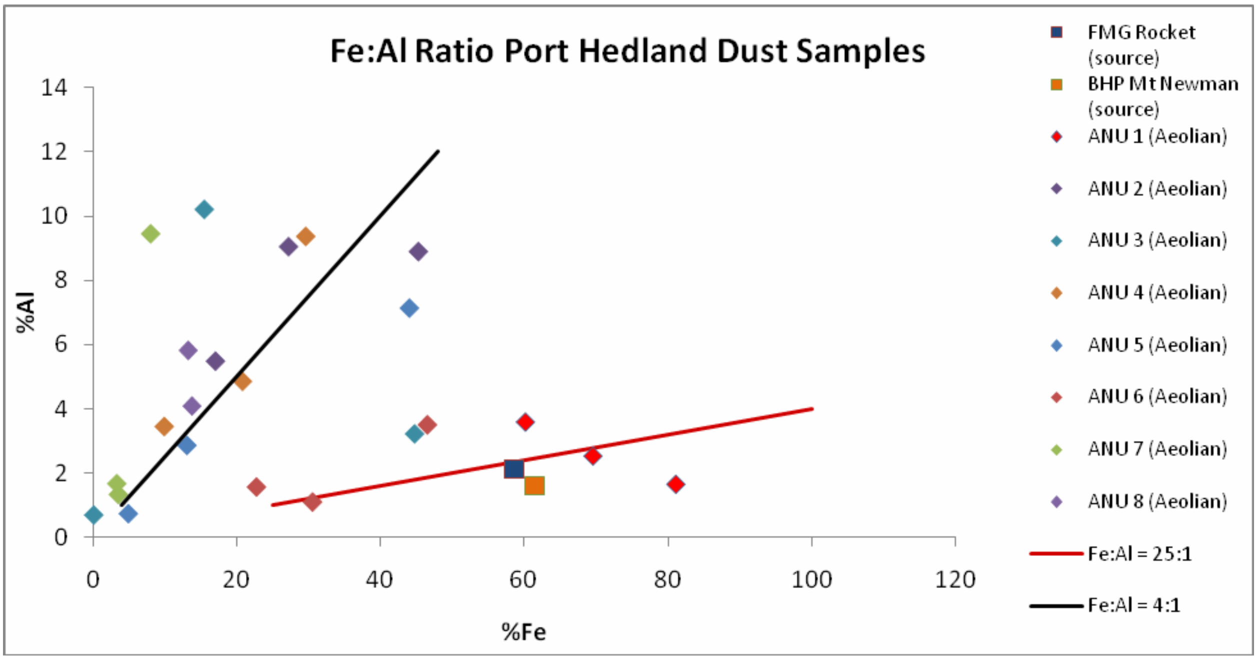

Figure 3: Fe:Al Ratio Comparison for all Samples

In further support of the suggestion that non-iron ore sources are making a large contribution to the aeolian material, the data from the BAM unit located 3 kilometres from any ore handling activity still recorded NEPM exceedences on 55 days during 2010 (Figure 2). In addition, the predominant wind direction on the majority of these days was from the opposite direction or outside of the iron ore operations sector.

Conclusions and implications for air quality management strategies

This study gives a preliminary indication that the contribution of non-iron ore sources to the aeolian material in the Port Hedland region may be significant in areas south of the port operations. Current air quality management strategies in Port Hedland focus almost exclusively on the management of iron ore stockpiles and handling operations. This intense focus on iron ore management is very much needed and this study in no way implies that it should be shifted from iron ore operations, in fact the extent to which control and suppression of iron ore dust is achieved is an excellent display of the industry's capability to implement and achieve management strategy goals. However, the results of this study suggest that current focus of management strategy may need to be broadened to include the management of potential sources of dust including dredge spoil and cleared areas where unconsolidated soils are exposed.

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